So the question that was asked of me was, is that true? Because the Defendants said no, this is a gasket cutting operation, we all know that cutting gaskets doesn't give rise to significant exposures, and thus this activity did not contribute to the Plaintiff's disease.

And the Plaintiff's lawyers, people for whom I have done work over the years, came to me and said: Are we right or are we wrong? And by the way, they retained me as a consultant first, and then when I gave them the answer, they offered me as an expert witness.

He worked in the shop of a subcontractor to the aerospace industry, and he made insulation pads that were formed of stacks of neoprene asbestos gasketing. His employer told him that the way we do this is to cut them with a band saw, and so he did that work exactly as his employer directed him to do.

Approximately over the period of 1958 to 1962, perhaps slightly longer, he didn't remember how many times he had done this, but he did remember that each time it was a full day's activity, eight to nine hours.

And did he have other asbestos exposures? Yes, he did. In the course of making this piece of

equipment for which the stacked gaskets were applied, he also cut calcium silicate block insulation, which was used in a conventional fashion for thermal insulation on a tank of heated liquid. Because the manufacturers of the block insulation had settled their case with the Plaintiff, I wasn't asked to compare those exposures; however, in the course of some work quite a long time ago with Dr. Balzer, we had done some studies of potential exposures on a short-term basis in band sawing calcium silicate block insulation, and I will present that information to you today so you can get some sense of the differences.

So, my assignment was perform a simulation of the gasket cutting activities and operations as described by the Plaintiff.

Number 2, determine whether the asbestos exposures arising from the gasket cutting operations were significant or substantial. What's not stated there is call the lawyer and tell them what my conclusions were.

Assuming then that the lawyer believed that this might be helpful to his case, then prepare a report and prepare for testimony at time of trial.

So what did I do? I went and bought some

gasket. Still bought it in 1996. I built a little-bitty chamber, 650 cubic feet, and about 3.2, 3.7 air changes per hour through a HEPA filtered unit. Bought a band saw, put it into the chamber.

And there is the band saw. There is the chamber. You can see it is one of these little-bitty adjustable negative air pressure units in the back there. And I operated it at the very lowest rate that I could so I wouldn't overwhelm this small chamber with air movement.

Here is the band saw. There is some debris. There is some of the pieces that I cut. Air sample filters set up ready to go.

I cut the sheet into manageable sheets. This was rolled — it was very tightly rolled, and I had to cut it into chunks about so big in order that I could handle it comfortably at the band saw. Put it down, put weights on it, let it flatten out.

I performed the simulation, and the samples were sent to a qualified lab. The R. J. Lee Group was the laboratory that I used. I determined the potential exposures. Called the lawyer. Wrote a letter. And the case was settled.

And that's a guy you might recognize there doing the cutting. And essentially, this is in the

actual course of cutting of this, and you cannot see any airborne dust arising, which may have some significance in terms of recollections of folks.

By the way, the Plaintiff in his deposition couldn't recollect seeing any airborne dust, except when he was cutting the calcium silicate material.

All right. So, what are my results? Well, I took a sample during the saber saw cutting of this material in order to determine whether or not there was any significant exposure. And you will see that I had the samples analyzed three different ways, by phase contrast microscopy, by total structures per cc by TEM, and by structures greater than 5 micrometers by TEM.

Saber saw cutting, less than .1 by PCM. By TEM, and greater than 5 TEM, somewhat higher. Here I have the personal samples. Four personal samples during band sawing. PCM concentrations, 3.1 and 2.2 and 4.9 and 3.1, on average about 3.3 fibers per cc.

Area samples, somewhat lower but not too much. Note that here these two samples, which I took for 25 minutes each, total volume in the samples of about 250 liters, were both too overloaded for direct

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preparation TEM analysis, and so I did not have them analyzed.

Again, area samples in the ballpark of about 2 fibers per cc. So about two-thirds as high as the personal samples.

Now, if we wanted to compare, which I didn't do for this case, but if you wanted to compare this work to concentrations that might arise from band sawing, some work that Dr. Balzer and Dr. Cooper and I did in the summer of 1970 was relevant. The sample and analysis was different, this was a predecessor method to the P & CAM 239, but essentially equivalent to that method, 37 and 47 millimeter filters were used.

We tested 3 different brands of calcium silicate, and we took 9 samples for each brand. And we had a couple of different area samples as well as personal samples in the breathing zone of the guy who was doing the work, and as opposed to 2 to 3 fibers per cc from the band sawing of gasketing material, here we have average concentrations in the range of 0 to 200 plus. So, although we couldn't determine fiber burden, I couldn't calculate fiber years of exposure because the Plaintiff couldn't remember how often or really for how long he did the work.

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I concluded that his exposures were both gnificant and substantial during each episode of and sawing the gasketing material, and his exposures ere well above the current and recent past OSHA PELs uring each episode.

Although the conditions were not entical, we had a bigger chamber, we used a fferent band saw, we used a different sampling and alytical method, it is possible to conclude that posures from calcium silicate sawing were in the ige of 10 to 100 times greater than from the gasket ving. And it was also possible to conclude, nember based on one sample during saber sawing, t band sawing produced higher concentrations than saber sawing.

Our recommendations — this was published ouple of years ago, by the way, in The Applied ustrial Hygiene mag, we concluded that such gasket ing should not be done without controls. And ember, I bought this stuff from the manufacturer e gasketing material. I called him up and said nt a roll of it and he said okay, and I sent him ey and he sent me the gasket.

We concluded that if the desired goal for rol is that asbestos exposure should be no higher

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than ambient concentrations of asbestos; i.e., no higher than about 1/1,000ths of a fiber per milliliter, then supplied air respiratory protection is needed together with other, as you would expect, other environmental controls.

Now, it is noted that as of 1996, the manufacturer specifically recommended against such uses as sawing these gasketing materials, and this was in the form of an enclosure with the material as well as the sticker on the box in which it came, so that as is usually the case, things now are not the same as they were then, conditions have changed and our understanding of the risks associated with asbestos have also changed.

If it is my conclusion as to how I would like to control this material, I would say don't do it. I mean, clearly this is a case where substitution of a nonasbestos product is entirely appropriate.

Thank you very much.

(Applause.)

FRED BOELTER: Thank you, Dr. Fowler. I am now going to ask John Spencer to give his presentation.

JOHN SPENCER: Thank you, Fred, and good

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morning to you all.

I think that is great.

As an industrial hygienist, I have been involved in a number of different federal agencies and worked for private organizations and I have my own consulting group now as I have for the past nine to ten years. As part of that I have been asked to do a number of exposure assessments, and asbestos has certainly been one of the types of exposures that even today doesn't seem to go away, so — however, the types of products certainly have changed, and as industrial hygienists we are asked the question to differentiate and evaluate exposures to asbestos and many other products, but just because a product has asbestos in it, does it carry the same weight; that is, does a friable product present the same type of exposure as an encapsulated product. So often I am asked to make the — to differentiate and determine the difference between those two types of products.

Now the example I am going to present to you this morning deals with exposures, primarily shipboard exposures, which having worked with the Coast Guard and worked on other Navy vessels and clients today who are involved in scrapping of ships, including military vessels. We continue to do these

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types of exposure assessments, and I want to differentiate the contribution of exposure from a friable product pipe insulation, primarily, versus an encapsulated product. And in this example I am going to use a gasket material.

We have gone, certainly in this country and around the world, from being concerned about exposures. Magnitudes of levels have changed. I know in growing up, in my time we were worried about rivers catching on fire and now we are concerned about parts per quadrillion of a particular chemical in that same river. So our priorities have changed but it is often difficult to differentiate the low-level exposure from some of the higher levels of exposure.

In this example, what I am going to utilize — what I am actually going to do is calculate a dose, a fiber year dose based on various parameters that I will identify in a moment, but we are going to assume this individual had six years of Navy experience, and we will define the tasks that that individual was doing. He worked around friable insulating materials, primarily removing these materials, as part of his job activities, and also in conjunction with that, removed some gasket products.

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Again, the purpose for retrospective exposure assessment is because as industrial hygienists we can't always go back in time and monitor each and every workplace environment. We don't have data for each and every specific situation that an individual is in, so there is a scientific process for going backwards in time and assigning an exposure as a best estimate, or in most cases, a worst case scenario.

In doing an exposure assessment, I kind of — in review of the literature, and in particular the one book that sold through the American Industrial Hygiene Association, The Strategies for Occupational Exposure Assessment, and also what used to be the NIOSH White Book, which is also now sold through the AIHA, The Occupational Environment's Evaluation and Control, defines the scientific process for doing an exposure assessment, and certainly there is many other papers on this process as well.

I have basically broken these down into four different areas, which includes characterizing the product itself, is it a friable product or is it an encapsulated product. Looking at the workplace environment, if I am going to do a retrospective

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exposure assessment, is the environment in the published literature or the reports that I am looking at similar to the environments that the individual that I am focused on worked in, is it similar or the same, was the ventilation the same, was the air movement, was the size of the room the same.

And then also as importantly, look at the task descriptions themselves. Is the data that we have on the actual tasks, including the frequency and the duration of those tasks, is that similar or the same as what is in the reported documentation; the literature or other studies that have been done.

And finally, were there controls that were used, local exhaust ventilation or other fans in the area, or even respiratory protection.

Other considerations: Are the sampling and analytical methods the same or similar from each of the studies that I am using. That is why we, as industrial hygienists, use a standard NIOSH and OSHA sampling and analytical methods, so we can compare our data over time and among one another. Unfortunately this is not always done out there, and you need to use caution when evaluating this data.

Just as a side bar, one of the areas that I have been looking at most recently has to do with

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brakes, automotive brakes, and it is very interesting to me. If you look at that data, a lot of it is — they might have PCM data, but they never did a bulk sample analysis to determine whether there was any asbestos in the product or not. They didn't do TEM data to determine whether the PCM fibers they were seeing in the air were asbestos or not.

So it is important that we use standardized sampling and analytical protocols, and when you refer to the literature that you use, only that literature that has those standardized and accepted protocols.

And what I am talking about there in particular, today we used the OSHA 7400 Method and we used the TEM method 7402 as a backup, not necessarily to count fibers, but to develop a ratio which is then used and applied to the results of the PCM data. In other words, if you find 50 percent — if you have one fiber per cc by PCM analysis, and you want to do a TEM because you think some of those may be cellulose fibers or cotton fibers, you use TEM, and if you come up with 50 percent of your fibers being nonasbestos, you apply that 50 percent ratio to your PCM findings.

That is how OSHA basically spells out and

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how NIOSH spells out the use of the 7400 and the 7402. It is not always used that way, so again you have got to use caution when you are using historical exposure data.

The other thing that I found, there are people today who are out there doing what they may call an exposure assessment, and they are using environmental air sampling and monitoring and analysis methods and don't clearly understand the difference between an environmental assessment, in which you are looking for the presence of a particular material like asbestos, versus an occupational exposure assessment, where you are looking to compare your results to the occupational health standards.

So again, one must use caution when selecting the appropriate data.

What I did for the data I am about to show you is I collected data from shipboard monitoring exposures done historically. And it was also based on a lot of my own experience in removing the, I would say, miles and tons of friable pipe insulation from Coast Guard and Navy vessels.

I also have data of gasket fabrication tudies that have been conducted over the years by a

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ariety of people. Probably the earliest and most well-documented one was one done by the Navy. Larry iukonen and others conducted a study, the Bremerton Naval Shipyard in the late 1970s. Used that data.

I have conducted my own assessments in hambers under controlled conditions, and I will talk little more about that, and have generated data hat was similar.

Obviously the shipboard environment, for ose of you who haven't been aboard, machinery paces are the main focus of the insulating aterials. We have done calculations taking ship ecifications and have actually computed the amount friable materials, pipe insulation and cement that is aboard the ships.

This is just from machinery spaces, and we : looking at amosite asbestos felted over almost ,000 linear feet. The insulation of cement was marily used around pipe joints and valve emblies, nearly 250 pounds of that material. This per ship. Just in the engine room and the boiler oms, doesn't even count the rest of the ship.

So we had a lot of mixture of both amosite l chrysotile, but you can kind of get the sense for amount of material on board these ships.

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From the exposure data, and it seems that Dr. Balzer's name and Dr. Fowler's name keep coming up in some of this historical data, and I really don't mean anything beyond that, it was just good historical data.

Did a number of studies and showed levels of exposure from 16 to almost 114 fibers per cc. There is other data out there. Another commonly quoted shipboard exposure set of data is a British study from P. G. Harries. Again, you have to look at — when you are going back and doing retrospective exposure assessments, you have to use caution.

In using some of that data, their numbers were even higher than this. I believe that some of that is attributed to they used a different type of asbestos product that contained much higher amounts of amosite in there. Can't necessarily explain the reasons why other than amosite. My own experience seems to be more prolific in its ability to become airborne. It is a dryer material and less bound into the product itself. So, you have to use caution in the data you are selecting when you are doing a retrospective exposure assessment.

Some of the data, and I will show you a summary of data that we use, but we actually — I

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have been involved in a number of gasket studies. And asbestos-containing gasket materials, as Dr. Fowler pointed out, is still available on the market today. Many of the encapsulated products, that is the case, packing materials, some roofing material.

I have been to Home Depot and bought mastic material to repair a roof on my building has 5 percent asbestos in it. So those products are still on the market.

There weren't a lot of gasket studies as there was for the friable pipe insulation for obvious reasons, thus the need to do some further studies.

When people started focusing on gasket materials as a potential source of asbestos exposure, these types of studies didn't exist because, for the obvious reason, that a friable product is much more likely to release fibers into the environment than an encapsulated product like a gasket material.

We actually set up a chamber where we had no ventilation and we fabricated gaskets, cut them out using a standard trade practices. We removed gaskets, again, using standard trade practices. Scraping and hand wire brushing and power wire brushing.

(This concludes side one. Please turn the type over for a continuation of the presentation.)

JOHN SPENCER: It was important for us when looking at gasket materials to make sure we had the environment clean. We actually wore Tyvek coveralls in this environment because we found that standard clothing, whether cotton or wool fibers, when you are looking at such low levels, would show up under PCM, so you are constantly getting interferences from other types of fibers.

So, that was — our only source of control was to control fibers from entering the chamber and from fibers emanating from the clothing that we wore.

Just to give you — the other thing that we evaluated as part of this task and compared that to the literature as well was the task times. And again, it is important to understand how long it took and how frequently someone would do these particular tasks in order to ultimately calculate a dose, a fiber dose.

Gasket removal with a scraper, generally 5 to 10 minutes. Carl Mangold, another industrial hygienist with an extraordinary historical background, we looked at his numbers that he had also

reported and studies that he has done, similar studies under similar conditions, and looked at — again, looked at the work as I knew it. I evaluated these types of exposures as an industrial hygienist with the Coast Guard, and so we had a good handle on what the task duration was.

And then removing/installing gaskets, looking at the whole process itself. Again, we went to the literature, we pulled out what data was available, we relied on our own studies and then my own experience as well to get a realistic handle on what these task duration frequencies were.

And then again, this is a summary of some of the reported literature on removal, gasket removal with scraping and hand wire brushing, work done by a number of people, including Fred Boelter, who is sitting here today.

There is generally a good consistency in the data. Some of the higher numbers, the Navy Bremerton study, which is the yellow bar, and the Cheng McDermott papers, it is interesting, the numbers are a little higher there, the eight-hour time-weighted averages, but they are different from the other studies that were done, which were in that they were actually done in the field, so there were

no controls for other sources of fibers.

The other studies that were done by Boelter and Carmel and EPI, that is my firm, Environmental Profiles, and Mangold, were done in a controlled setting in that we controlled for other sources of fibers.

So as a result, you see the actual contribution of fibers from the gasket-handling activities.

Now, what I did is I took the data from my review of what the individual described they did. They removed pipe insulation. How often did they do it? What was the frequency and duration? We looked at what they did with regards to gasket, handling gaskets, working with gaskets. And they defined the vessels that he was on, the number of days that he was on that vessel. And there is generally a vessel service history that you can pull this information directly from. You describe the job tasks. This is on duty. Removing pipe insulation. Claims to have done this four hours a day, one time per day. So his total time was four hours per day.

As to gaskets, again, he said he did it four hours a day, one time — and we just consider that one time a day. Off duty, 16 hours aboard that

vessel.

Here again the same vessel, removing pipe insulation, 8 hours per day, 7 days a week. This was a military type setting. We wanted to present a worst case scenario, so quite often in the military they are working 7 days a week. They really don't have much time off when they are on board these vessels.

Again, this is true for the gasket, removing and installing gaskets, 8 hours a day. We put 5 days a week. Again, that was based on the description; yeah, I did this a little less in terms of handling gaskets. The pipe insulation was something I got into a lot more.

So, the potential exposure for the pipe insulation work, we just took an average number of 16 fibers per cc. Now, that may be a low number, and perhaps it could be a little lower. I think it is a good average number. I think certainly there is an argument for that number to be higher based on the literature.

And he only did this 4 hours a day, so his eight-hour time-weighted average was half of 16, so that is 4 fibers per cc.

He did this, his task occurrence was 45

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days per year. You normalize that to a number of years. This is — so we used — I don't know what we used here, 365 or 240. Or I am sorry, we divided 45 by, I don't remember now, 240 or 365, and you get the number of equivalent years. And he did this for 6 years. And again, we carried this through all the way for each activity that the individual did.

By the way, this is a very simplified version of this task analysis. There is a lot more detail that goes into this, but time does not permit that description.

So, we have removing pipe insulation, an equivalent number of days, 6 years times 45 days per year. Well, there is 135 equivalent days. His cumulative exposure, it looks like 5.9. If I am reading that correctly from here. That is 5.9 fiber years. Unfortunately I have PPM years up there. We do the same sort of association for benzene. Anything that has a cumulative type of exposure you use the same sort of approach for.

And then over in this column it is just :arried out. It is an additive sort of effect. So ıere we have the pipe insulation for his 6-year :xposure at 5.9 fiber years — I am sorry, that was ›n board this ship for 2200 days. We added up each

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hip and the amount of time that he was on each essel removing pipe insulation.

We assigned a background level of asbestos 'hile just being on board the ship. Again, there is ata. The Navy has conducted studies. I have been ›oard ships underway and measuring asbestos as ickground levels, and we inserted that data, so :ovided the exposure based on that data as well.

And then we have removing and installing skets under this 2200-day period. There was an uivalent of 180 days of removing and installing skets. And his cumulative dose as a result of that ıs .005 fibers per cc.

You add all these up and ultimately what u come out with for insulation, you add up just the ulation exposure, 7.4 fiber years.

The gasket exposure data was 0.005 fiber ırs. So, ultimately if you are adding up his total nulative dose, you would add all the gasket data ether, you add all of his years in the different sels that he served aboard with his pipe ılation exposure, and that is how you come out ħ a cumulative dose.

And that is how you compare one against — product type against the other, whereas in years

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past when I was working on board these ships, it was nearly impossible to differentiate the exposures from gasket and the total contribution of exposure on board the ship because we had not only asbestos all over the ship, but we had fiberglass and cellulose and other sources of fibers on the ship. It was hard to make that distinction. This is a process that allows us to make that distinction.

These types of — this type of approach is good in evaluating what I call a worst case scenario. And I think when you approach this, you take the data in that respect and do a worst case analysis, what we tend to do as industrial hygienists, since we can't monitor everyone under every situation at every point in time.

It is a long and it must be a — it is a meticulous process to make sure that you have selected the appropriate data, that you have applied the appropriate work task frequency and duration, and that you have looked at the product to make sure that it is similar or the same as the historical types of products.

And so through this process one can get an understanding of the relative contribution of various products. And again, you can use this with other

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types of exposures. Benzene is another good one if you want to evaluate different types — different exposures or contributions from different sources.

One of the things that I have found in doing these types of assessment, as industrial hygienists, we use professional judgment, and I think through experience and education that you can apply your common sense to this type of approach, but it is a scientific process that I believe can be utilized to clearly differentiate one type of product from another.

So with that, I thank you for your time.

FRED BOELTER: Thank you, John. The next speaker is Dr. Rasmuson.

JIM RASMUSON: Good morning. Larry Birkner sends his regrets that he couldn't be here. I am honored and pleased to be here in his place.

The objectives that I would like to talk about this morning are to explore methodologies for doing what we are talking about this morning, but particularly with respect to individuals who have had work over a varying history, in other words, construction workers, maintenance workers, people who have — it is hard to pin them down, they are moving from site to site, they are doing different tasks,

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some sites are being exposed to asbestos and other sites they may not be.

I want to demonstrate how the uses of ranges and a particular technique for dealing with those ranges, the Monte Carlo simulation method, can be used in the absence of specific exposure and specific exposure factor data, and I want to discuss how that can also be applied to the — taking a look at uncertainty analysis relative to the estimated dose reconstruction.

Particularly I want to discuss the differences between variability accuracy, and I want to talk a little bit about the limitations of the method as well as the strengths of the method.

I think that this type of work, it is very important to, just in the beginning, say that we need to not try to find data to support our preconceived notions, but rather let the data drive the conclusions. And this is almost true without saying it and yet it is something that as consultants I think that we need to remind ourselves of once in awhile.

This is one potential solution to the problem. This is a time machine that we have designed, and the rest of the talk will be discussed

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and geared towards that. But, actually, no.

I want to talk about the elements of the retrospective exposure assessment very briefly. Others have touched on that. And then we will try to get through that quickly and get into some meat.

Basically what you want to do is determine the work and exposure history, assign an exposure range to each exposure event, estimate exposure factor ranges. Sometimes the exposure events are known for the primary worker, but people in the same area have also been exposed, or they are using different types of products with different asbestos contents, and then we have to apply factors to those primary exposures to help estimate the exposure ranges for the workers being actually exposed.

You want to calculate each exposure event dose range. Now an exposure event dose range is a specific job working with a specific product. In my experience, the more slices you can make of the work history, the better job you can do because you are paying more attention to details. And I will be talking about that later.

The danger in doing that is sometimes if you are working off of a work history, which has been gathered by interviews or from deposition testimony

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or something of that nature, there is gaps in periods of time that can be missing and one has to be careful to try to cover those periods as well and include that in the uncertainty analysis.

Then finally, the estimated doses for all the various exposure events are added together to come up with a lifetime exposure range.

The work and exposure history is determined by interview, deposition testimony, workplace and other records. There is other ways of doing it as well, using personnel records, Social Security records, union records, military records, whatever you have that allows you to piece that together.

In interviewing workers, these are some of the principles that I have come to adopt. I don't always get to interview workers, particularly if I am working for attorneys doing that kind of consulting work for Defendants. On the other hand, when I have worked for Plaintiff attorneys, and in other situations, I have been able to better interact with the workers.

These are some of the lessons I have learned from that type of work: Basically to avoid leading questions, have your forms, your questions,

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predetermined. A one on one interview is better so you don't have kind of the group biasing and developing kind of a group thing, pushing things in certain different directions. I try to standardize exposure descriptors. Try to use common, if I am talking about estimating a dose, for example, to an organic solvent or dioxin-containing material, that sort of thing. We try to standardize relative to splashes how many drops, how many quarts, what percent of the surface area of the arm, in other words, the top of the arm, the whole arm, did you get wet up to your elbows, was it just your fingers, how long did it stay wet, did you go wash your hands. Things of that nature. We try to put words in terms — try to use words that the workers can relate to.

We visit the site whenever possible. That is very important. Estimations are best made in ranges because we can't be real precise in this. And if we can get estimations from several sources, that is always the best.

The work and exposure history characterizes each exposure event. We try to define the type of ACMs in the process. We are talking — the other slide was more general, this is for

asbestos.

The process, hands-on, bystander, et cetera. What duration or overall percent of the work week are we talking about. That can be in terms of minutes, number of times, lots of different units.

How often did that happen. Over how many years did that happen. It is the old intensity, duration, frequency and length of time idea.

Typically all of the information is typically known within broad ranges, and maybe broad ranges at best.

I found it useful when I organize data to put it into a spreadsheet, taking into account the relevant dates, the employer, location, occupation, job description, work environment, what type of product is it, who manufactured it, the personal protective equipment, the duration/frequency/length idea. And I also document by each exposure event in :he spreadsheet the related exposure values from the .iterature, factors, basis for estimations, and then : do the exposure calculations all on the same ;preadsheet. It is just very useful to kind of keep ›rganized in that sense. There is different ways of loing it. This is just the way I happen to do that.

Another useful thing that sometimes I do

; I come up with exposure range categories, kind of rder of magnitude values dividing the exposure inges into seven categories, for example. It kind f goes like this, less than .01, .01 to .1, .1 to 1, : cetera. Kind of an order of magnitude thing. And ıere I use judgment on each exposure event taking .to account bystander factors, differences, all the ırious exposure factors and what the literature ight say, and I use judgment. But by using judgment ı many individual events, the overall — I found in y experience that the overall assessment has some easure of objectivity to it.

Basically what we are talking about when : assign the exposure range is we are talking about ;torical databases. There is a need to standardize :se. I think that the more we can talk as a :iety and to each other about what exposure ranges : are using, and then we can standardize this, it is :ng to be — we are going to create more ›roducible exposure assessments from one industrial ;ienist to another.

We can also do — we have to be very eful because short-term measurements oftentimes e been made, and that is different than TWA ıes, and sometimes the literature is confusing and

we have to be very careful about that.

We can make inference from measurements involving similar materials. I have tried to do modeling. The biggest limitation I found when I tried to model the exposures is an unknown source term, that is trying to figure out what is the mass per unit time that enters the air. And I have been able to do some useful work relative to particular exposures using various models, but modeling is problematic in many cases. But principles of modeling can be used to modify data and to better understand.

For example, if you move an indoor exposure to the outdoors and you use a box model, you use the same source term in terms of mass per unit time being put into the air, you can make generalized conclusions. But there again, you have to make — you have to have caution so that you don't overinterpret what you are doing.

Basically there are elephant-sized exposures, there are medium-sized exposures, and there are snail-sized exposures.

You know, without exposure data, there is quite a bit you can do based on judgment. If you are talking about friable products, then you are talking

about exposures that are generally greater than the 1 to 20 fiber per cc range, either in that range or greater.

Or as Dr. Fowler just discussed, if you take a friable — nonfriable material and you apply a power tool to it, then of course you can also get into that range.

If you are talking about materials, such as cloths, papers, things of that nature that can give off a little bit of dust but they are not really friable, in my experience they are typically in that 0.1 to 1 fiber per cc range on a time-weighted average; of course it can be less if you are not handling the material much.

If you are dealing with nonfriable materials and you are not rendering it friable, with power tools typically you are in the less than .01 to .1 fiber per cc range. And some simple categorization schemes like this can help fill gaps. And in fact I believe the National Academy of Sciences in their exposure assessment guidelines talks about making extrapolations like this to fill in data gaps.

The exposure evaluation process then essentially is the industrial hygiene process, the

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first two steps, the recognition and the evaluation.

First of all, we recognize the exposures.

We take into account time factors. We take into account exposure data. We take into account factors such as dilution, distance from the process. We take into account the percent of asbestos in the product.

For the case study I am going to talk about this morning, typical exposure factors that I used, and it would vary on a situation, obviously, but if you make these exposure factors wide enough, essentially you can make them wide enough to give yourself some degree of confidence.

If you are covering a factor to take into account the fact that you are not doing the work yourself but you are in the immediate area, if you let the factor go from 1 to 30 percent, you know, you probably covered it unless you are working elbow to elbow, or unless you are, you know, several hundred yards away or several hundred feet away.

Time your other trades. That is going to be very case specific. But, in the case I am talking about today, 2 to 50 percent seemed to cover it.

Difference between the indoors and the outdoors may be a factor of between 2 and 20. The percent asbestos in the product from what I have seen

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is generally — has a linear dependence on what gets into the air, all other factors being equal.

Exposure factors can have somewhat narrower and alternate range values with specific information, but oftentimes I wind up working with ranges like this or some modification of this.

This is a tracer gas study that I did to try to further take a look at the so-called bystander factor, that is the factor that would be in the workplace surrounding an individual involved in an asbestos exposure. Used sulfur hexafluoride as a tracer gas, and you can see that under very stagnant conditions indoors, the surrounding environment, by the time you get 25 feet away, is down to 1 or 2 percent of the continual release occurring.

We tried to simulate somebody scraping asbestos, and we had a continual release as we moved the hand back and forth, and we had monitoring points set up in this building as indicated by the various dots.

On the other hand if we have some directed wind, indoor wind in this case — and this was just a different ventilation condition, different setup in the building by turning on and off various ventilation systems, you can see that the down wind

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values, when you get about 10 feet away, are about half of the primary exposure. When you get 35 feet away, it can be 20 percent. When you get to be 75, 85 feet away, it can be something like 10 to 15 percent.

On the other hand, the upwind concentrations are zero, and to the sides are zero, so on the average you are still talking about, oh, 10 percent or so, or less in the same general work space.

This has to be tempered by the fact that if you are in a confined area you can have dust buildup in the room, for example, on board ships in other confined areas, and if you had a very vigorous process, you simply can fill the space with fibers and, therefore, we have to be conservative when interpreting this data and that is why I use a wider bystander exposure factor when I actually do these estimations.

I want to get into the case history. This was a pipefitter/plumber, he was born in 1933. He developed lung cancer in 1999 at the age of 65. He had some pleural plaques. He had a low degree of interstitial fibrosis. He smoked from 1950 until 1979. He didn't smoke any Kent micronite filters

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with crocidolite.

He was questioned in detail in nine depositions and in trial testimony about his work history. Coworker depositions were available also.

He worked as a pipefitter/plumber mostly in larger urban commercial sites, 85 to 90 percent new construction. What is the significance of that? Well, if he is in new construction, he is not removing pipe covering to any appreciable extent, except in some instances tying in to existing systems when he is building a new building as part of a complex.

He was a hands-on apprentice when he started. He became a mechanic. He worked his way up becoming a foreman, a site superintendent. His primary exposures lasted until about 1975 to 1980, around 20 to 25 years of exposure.

There was information on 45 sites evaluated through 1980. He had limited hands-on asbestos disturbance. He was in the vicinity of pipe insulation, fireproofing, and gaskets and had some hands-on associated with these types of material himself.

He installed asbestos cement piping using non-power tools. He reported working frequently side

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by side with asbestos pipe insulators; however, it was often fiberglass materials. He reported working in the vicinity of tapers and sanders, spray application of fireproofing and joint compound mixing and sanding.

I want to talk about the application of the Monte Carlo simulation on this case history briefly. Basically what Monte Carlo is, it allows you to take several distributions, in this case there you see the distribution for exposures associated with dry mixing, you see the distribution associated with sanding, for application for cleanup.

The Monte Carlo technique allows a random ıumber generator to generate values in association vith those distributions, and the process is epeated, for example, 20,000 times. Equations are et up to combine those exposures, taking into ccount the percentage time for each of those dry ıixing, sanding, application, cleanup, and those ercentage times can be put in as a range as well, nd then taking into account the fact that some of ıe time the taper/sander is just applying or not eing exposed, or you could take — if the :per/sander also puts up sheetrock, you could ssentially have a zero exposure for that activity.

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The whole idea is the Monte Carlo method lows you to combine these various distributions to an overall distribution that you see on the ›ttom of that chart, which would be indicative of a pical or average time-weighted average for an ght-hour day, assuming those distributions.

And you can see for the taper/sander a 0-5 fiber per cc range is useful with a central ıdency around 3 fibers per cc.

The assumptions that I used for the case tory were wider than I usually use in this example cause I wanted to be inclusive of additional IH wpoints. This happened to be involved in gation, and the Plaintiff's industrial hygienist l higher ranges than what I usually use, and so I l okay, let's not argue about this, let's just ɛe the ranges wide.

I also use wider than — wider exposure or ranges for bystanders, et cetera, than what I ık is necessary, but I wanted to be inclusive. l basically this is an illustration of a what-if ıario, what if the exposures are this high. What e exposure factors are in this range. Or you use the technique to come up with a best nate.

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And so it is very careful to find what you are up to in the begin so that you can probably interpret what the results mean.

I want to show you with 40 different exposure events or potential exposure events, 45, whatever it was. I can't show you all of the assumptions that went into this, but I want to show you a few just to give you a feeling for it.

For the duration, this is one of the exposure events. We had a four to seven month. He couldn't remember precisely, so he put in a range, and we made the probability the same, represented by that green rectangle.

For the percent time exposed, as a bystander to insulation work, he had some descriptors that he used in words but didn't have an exact number. So we came up with a reasonable range of 10 to 50 percent, a factor of 5. For a bystander factor, sometimes he was right in the same room, right next to them, and other times he was at some distance. Again, we could have let this go essentially 0 to 50 percent, but it doesn't change the result much, so we just let it go at 10 percent to 50 percent.

The primary worker exposure, if you look

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at the Cooper Balzer study for general commercial sites, you get about an average of 3 fibers per cc in the 1960s; on the other hand, there are alternative studies out there, but we allowed the highest part of the distribution to be a 3 fibers per cc, but we allowed the range to go from 1 to 43 fibers per cc using the triangular probability distribution that you see at the bottom of the page there. Or bottom of the slide.

Similarly for sheetrock tapers and sanders, when he was in their presence, we use the same time range. His words indicated a little less time of exposure, so we used a range of 5 to 25 percent. We used a 10 to 50 percent bystander factor. Probably too high. But again, we wanted to be inclusive. And instead of the essentially 1 to 5 fiber per cc range that I showed you, we extended it from .25 to 10 for the central with the highest part of that at 3.

Similar for people, labor sweeping up, you can see the data there. Removal of asbestos and pipe/block insulation, sometimes he would do tie-in work. In this case he did it for two days. Percent time exposed during the day seemed to be about 5 to 10 percent.

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He worked hands on with somebody else doing this. Sometimes he did it and sometimes his partner did it, so we used a bystander factor there of 50 to 100 percent.

And for the primary worker exposure, there can be a great deal of variability when you are removing asbestos. Again using Cooper Balzer as the most probable, we took 8, but we allowed the exposure range to go from 1 to 97.

Scraping of fireproofing, Paik has an article where he puts things in terms of geometric means and geometric standard deviations, and he has done this for essentially the eight-hour workday rather than the short-term event. And you can see what that distribution looks like graphically at the bottom there, it ranges from about .05 to 2 fibers per cc on a time-weighted average basis.

But essentially you can input into the Monte Carlo, you know, a formula, a geometric mean, a geometric standard deviation. You can input triangular distributions or even probability distributions as suggested by those rectangles.

So how did it turn out? Even using the broad exposure ranges, when you make a lot of little slices, you get a range that looks like this. And it

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is really not as broad as you might think, considering the broadness of some of the assumptions that go into doing it. You can see the 95 percent confidence interval. It is in blue. 2 and a half percent of the data on each side of the distribution is in red. And so 95 percent of the simulated data points occur in the center as represented by the blue lines.

We have roughly a factor of three between the low and the high. We do the 95 percent confidence interval.

How can the use of such wide input ranges provide such a, I think, tight range. I think a factor of three. I almost tried to make the ranges wider so that the final result is broader. It is almost embarrassingly too tight.

But what I found is that the use of many exposure events per assessment, in essence, slicing up the pie into many events effectively increases end. It is the best analogy I can give you to try to explain this, which reduces the standard deviation of the mean total dose result.

Another factor is that many of the exposure events do not significantly contribute to the total dose, and that is almost the antithesis of

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that first point, but one can determine what is doing what by running a sensitivity analysis on the Monte Carlo.

I think the basic idea here is that if you have a lot of data, you are taking a mean, the standard deviation of the mean gets reduced by the square root of the number, measurements that go into the mean or the so-called standard error concept.

To compare it, sometimes it is useful to compare a one dose with another. For example, in the previous talk there was the comparison of the gaskets with the pipe insulation.

To cover the range of possibilities and to complete the uncertainty analysis, we need to essentially divide one range of values by another range of values. The Monte Carlo technique is one method to perform this type of analysis.

In this example, one of our clients, which I will fictitiously call Acme, we came up with a range for his products, he was actually a boiler manufacturer, and you see the range up there. You know, it is a very trivial exposure, it is down in the background range, but it varied from close to zero to about 005 or 006 fiber per cc years.

If we want to know what percentage or what

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fraction of a lifetime exposure that represents, we essentially have to divide that by the total lifetime asbestos exposure. And the Monte Carlo technique allows us to do that. What we can do is take the Acme-related exposure, divide it by the lifetime exposure, and come up with a ratio-to-lifetime asbestos exposure, which you can see is running from essentially 0 to about 7 parts in 10,000.

Uncertainty analysis is a very important part of any kind of exposure assessment or risk assessment. Wonder if they ask themselves does the exposure assessment make sense. We can do comparisons to other types of workers. For example, for this pipefitter, if I started getting results that were indicative of insulators, I would say well, it probably isn't making sense.

You can make simplified estimations. Instead of cutting the pie into many pieces, you can try to get a sense for the frequency, for the various activities over a lifetime and come up with simplified estimations, and you better get the same results.

Is it consistent with what the literature says about the occupation. There are some estimations of pipefitters in the literature relative

to disease rates compared with insulators. And this has been primarily for shipboard work. But that can be viewed as a worst case.

There is a difference between variability and accuracy. Even though I showed you the variability, that variability is simply the variability associated with the assumptions that I made. It is not the variability from one person doing the exposure assessment to another person doing the exposure assessment.

And it shows variability, but the accuracy of the analysis is only as good as my assumptions, and so it is important to not think of the variability that one determines as a full uncertainty analysis. One is to think about both variability and accuracy issues.

So it is important not to overstate the utility of the confidence interval range that you determine by this method, and at the same time it is very useful, and I don't think it should be understated either.

How good is it from an accuracy standpoint. What I have done is before I started doing Monte Carlo, I essentially do a minimum kind of mid range and a maximum. And where I had asbestos

body per gram information from pathologists, I tried to correlate the two, and of course the problem is that chrysotile exposures, the chrysotile fibers don't persist in the lungs, the amosite fibers do, and on top of that, all of us make asbestos bodies at different rates, individual to individual.

Nevertheless, if you take the regression line through the data, ignoring those two green points because those are not my data, that was some other data.

(This concludes tape 1. Please go on to tape 2 for the continuation of this program.)

SPEAKER: Code number AIHce 02/Forum 244, part 2.

JIM RASMUSON: — lines going from high to low. And I think it does illustrate the utility of working with ranges when coming up with this type of work. Does that indicate accuracy? No, it indicates correlation.

This is an example of retrospective exposure assessments that I have done for dioxin, and it didn't look this good until we averaged the results from two different laboratories. The risk of cancer from TCDD is using the retrospective exposure assessment, primarily looking at the dermal absorption pathway and taking into account body

weight, the sort of things you do for the EPA risk assessment.

But is it accurate? There is variability. The answer is well, it is accurate to a degree, but when we look at — when we determine the half life of the decay of the dioxin in the body, we come up with a three-year half life for this, and CDC has done this on many more people and has come up with a seven-year half life.

And so while we have tremendously good correlation, except for one data point here, it isn't perfectly accurate. And so one has to think about precision, variability, accuracy in order to put your data into perspective.

These are not single-valued estimations, and one has to try to continually get at the idea of what is my variability, what is my accuracy, how well would my results compare with another industrial hygienist doing the same type of work.

One of the interesting things that is becoming more and more important is the difference in fiber type. There is good workers on both sides of this issue. Some would think that chrysotile is very potent for mesothelioma. Many of the epidemiological studies do not support this. And one possible

utility for the Monte Carlo analysis that I have talked about is to do a fiber type analysis within an exposure assessment, come up with dose percentage of exposure.

In addition, the technique is useful for specific situations, accidental releases. I have used it relative to risk communication situations involved with maintenance workers, that sort of thing.

Thank you very much.

(Applause.)

FRED BOELTER: Thank you, Dr. Rasmuson. The next speaker is Dr. Bill Dyson.

BILL DYSON: Well good morning. I have been sitting about as long as you have and it felt good to me to stand up, and so I thought you might want to stand up for just a second. Stretch a little bit.

I will continue to talk while you are stretch, though, to tell you why I have chosen this topic, which is just a little bit of an extension beyond exposure reconstruction, and that is to talk about mesothelioma cases.

What is at risk in this country today is very simple to calculate. There are around one per

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hundred thousand cases of mesothelioma is the rate, and so that means that we have somewhere between 2500 and 3,000 cases occurring each year within the country. These are — what is at stake for each of those cases is somewhere between 2 million and $10 million, so if you multiply that out, and assume that, say, 50 percent of them, or 40 percent, even, are going to come to a legal setting where the claim is that it is due to asbestos exposure, you are talking about an industry somewhere between 2 and 12 billion dollars a year. So there is a great deal at risk in talking about this.

Sorry, I have got to go back. And I don't know how to go back. Okay, back where I should be.

What I want to talk about here is attributable risk based on going a bit beyond just the simple calculation of exposure dose. This is applicable to mesothelioma. It is not — it is certainly not applicable to lung cancer or to asbestosis from asbestos exposure.

The objective is to attribute the risk to individual exposure sources and determine the relative contribution of each of those sources to the total risk that the individual might have.

Obviously if the mesothelioma is an

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asbestos-related disease, then the total risk necessary to cause the disease is the sum of the individual risk attributable to those sources. And the relative contribution is the ratio of the risk from the individual sources to the total risk.

I only pushed it once.

The first cut at this is a risk assessment based on exposure dose, and the equation or the proportionality that we would use here is that it is proportionate to the exposure intensity and the duration of exposures. You have heard that several times this morning.

This model for epidemiology does not fit the data; however, if you use it, and it is necessary to do this in each and every case, you can look and see if the lowest cumulative doses at which mesothelioma has been associated with asbestos exposure, is reached. And in my estimation, in epidemiological studies, that is somewhere in the range of 1 to 5 fiber years per cc.

I am going to try. There we go.

The particular example that I would like to use here is the case of an individual who early in his life was in the Navy. He came out and essentially became a carpenter's apprentice and then

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worked his lifetime as a carpenter.

The individual sources of exposure here were 5 in his history, that was he worked as a boiler tender between the years of 1944 and 1946. For a period of time between 1960 and '61 he was cutting some asbestos cement board in building a cooling tower. He also used vermiculite to mix with plaster over the period of 1955 to 1961. It is a similar exposure but cutting shingles, asbestos cement shingles between 1950 and 1960, and then finally the exposure that he might have had as a result of drywall construction.

Dr. Rasmuson gave you the data on exposure from Monte Carlo analysis for drywall tapers, and you will see how I use similar data to that.

Doing just the exposure dose calculation in this case, the Navy, and I do it on a worst case scenario basis and do it in a fairly simplistic fashion because I find that I can explain it better to juries if I can get it down almost to sound bites and small categories like this.

But, the Navy exposure I attributed a .1 fiber per cc over a 2-year period for a total dose of .2 fiber years per cc. And in going on down, you see the various attributions here. But, particularly the

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drywall exposure I use the upper end of the range on that, again, for a worst case scenario of 10 fibers per cc. He did it in 50 homes, 5 hours per home, so his total cumulative exposure here was about two-and-a-half fiber years per cc.

The largest contribution of which, just based on an exposure dose analysis, is the drywall application. Now, what I would conclude from this, of course, if I stopped here, is that he did have sufficient exposure or sufficient minimum exposure for the mesothelioma to be asbestos related, and if I looked at it just on the basis of exposure dose alone, I would attribute a good portion of his — the attributable risk here to the drywall installation.

But let's take a further refinement of this model. And that is a risk assessment based on latency. This is commonly called the Peto analysis in the world of asbestos litigation, at least.

It was — the mathematics of it were shown in a paper by Morgan in around 1988 that he tongue in cheek called who done it, or assessing liability in asbestos litigation. And what this says is that the risk is proportionate to the period between when the diagnosis for mesothelioma occurred and the initial exposure for that particular individual to

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asbestos raised it somewhere in the range of the third to the fourth power.

In applying this, we used three for chrysotile exposures, four for amphibole exposures, or some people used just an average of 3.5 for mixed exposures. This acknowledges what we have seen in the epidemiological literature that early exposures contribute more to the risk of mesothelioma.

If we applied this to the case of the ndividual in this case, the relative risk, just based on those latencies from the diagnosis of nesothelioma in the year 2000 and the early exposure periods in the Navy and drywall and so forth, again he relative risk looks like the drywall exposure's he biggest contributor to this individual's risk of nesothelioma.

The others, again, based on the wide time rames and so forth for the asbestos cement siding on he house, gives a large relative risk as well.

But then we take it a step further. This ; a risk assessment model that was used, it was roposed initially by Dr. Nicholson, it was used by)SHA in their risk assessment for asbestos to etermine the permissible exposure limit, and what is says is that the absolute risk of mesothelioma

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proportionate to the exposure intensity as well as ie latency raised to the third power.

There are few refinements of this, of ourse. Some people say that the minimum latency is) years, so you need to subtract 10 from the latency at is calculated here.

But for the few epidemiological studies at we have that show a dose response relationship r mesothelioma, the proportionality factor here has en estimated about 10 to the minus 8.

So again, taking this same example and plying it to the individual that we have used fore, the slight difference and nuance of this in s application is that you will notice that the ensity numbers that I am using here are different.

They are not different for the Navy cause that was a fairly continuous exposure, but in : case of the cutting of the asbestos cement board re and here, what I used was the dose, the total se that I calculated, divided by the number of rs. In this case it was .4 fiber years per cc, it is divided by only one year, so that is the rage exposure intensity in fibers per cc. Here are dividing it over a 10-year period the same e, but it is — the intensity average and

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intensity over that period of time is lower.

This is necessary to do because the — if you don't, the numbers get skewed on this. And again, note where I used a 10 for the intensity for the few months or the 50 homes that he did drywall work in, if you attributed over that entire duration, the average intensity over that duration is 0.7.

So now we begin to see a slight shift in the relative risk of mesothelioma using this particular model. Now the drywall element of this exposure goes down as a relative contributor, and the Navy portion of it goes up somewhat.

The next refinement of this model, Dr. Rasmuson mentioned that we have interesting information about the potency of various fiber types to cause mesothelioma. I don't think that there is any doubt in anyone's mind that there is a different potency or certain variability by fiber type.

The best estimate that we have from this comes from a fairly recent article of Hodgson and Darrington, and they say that the relative potency by fiber type between the fibers ranges from 1 to 100 between chrysotile and amosite — they didn't mention tremolite, but it is in the same category — and 1 to 500 between chrysotile and crocidolite.

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So using this information we can refine our model somewhat further. And in this case now, say that the risk of mesothelioma is proportionate to not only the exposure intensity and the latency cubed, but also the potency of the fiber type involved.

Applying that particular model, the chart becomes larger, the numbers become smaller, and I apologize to those of you in the back of the room, hopefully you can read some of it, at least.

We have an interesting situation because of the fiber types. Most of the fibers here in the cutting of asbestos cement board, and in the drywall we are talking about chrysotile where we attribute a potency of one.

On the other hand, in the Navy we have a mixed exposure with amosite, and the vermiculite exposure is to tremolite where we would put an exposure potency of a hundred.

When you run the calculations using this particular risk model, things change very dramatically, the two contributors, the two largest contributors in terms of risk to this individual's mesothelioma were the Navy exposure out here, and the vermiculite exposure that he had.

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Primarily as you can see it is due to latency and potency as opposed to the intensity element of it. Based on this, I conclude, at least, that exposure dose estimates alone are not sufficient for attributing risk and doing relative risk attribution in mesothelioma cases. As they are, it is sufficient in lung cancer and asbestosis cases. The latency and potency of the fiber type are very, very critical factors and oftentimes the most critical factors.

And then finally it is my opinion that all factors must be considered in the risk assessment for mesothelioma cases to get an adequate idea of the relative contribution of the individual components of the exposure.

Thank you so much.

(Applause.)

FRED BOELTER: I am going to talk about two cases, one involves a historical exposure assessment similar to the previous speakers where we are looking back in time using information gleaned from interviews as well as depositions or studies, and ultimately calculating a total lifetime dose.

Another study I am going to share is more contemporary experience where it is not unusual that

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asbestos is in buildings today, and people encounter it accidentally. And I will show how to use the same concept of dose reconstruction to determine a dose associated with that to communicate the significance of the exposure and the risk associated with it.

What we have developed is software to be able to look at a dose reconstruction. It is built on the principles that all the other speakers have discussed; namely, the establishment of exposure events and the building of a timeline.

What is shown here is a small portion of the discrete events. Each line is called an exposure event, and it has a start date and a stop date and thus a total number of days. For a default value in determining the number of equivalent years between a start and a stop date on a calendar is 250 days. So 250 work days per year equals one year for the purposes of doing a fiber year calculation when looking at an occupational experience.

So what we do is in looking at the person's work history, develop this timeline; namely, what was their first employment or engagement with asbestos, through to their most recent or last one.

Each timeline is either defined by the period of time that the person was employed for a

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particular employer, or it is defined by specific activities that are performed at that employer. So this summary table is the employment periods.

For each exposure event, therefore, each line that I showed on the previous chart, is an exposure event form. This will contain the name of the employer, the location. In this particular case, it was a deposition source. So the location specifically in the deposition where that information was contained, where the employer was located, information related to the activities, and the nature of the activities, in this case, the renovation of homes, where those were located. And then the individual activities that were performed for this exposure event, therefore — or the activity was the working on renovating homes, but there were a series of different specific activities that could have an exposure associated with them while doing this work, such as cutting through flooring, pulling cable, cleaning up, removing insulation, cutting through the ceiling. Each of these are specific activities that have to do with this exposure event.

What we also have is links to literature so that there is a basis for each entry in the process of building this timeline. For each of those

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activities that I showed on the previous chart, there is going to be a specific activity information summary.

The information, for example, cutting through the floor, there will be a description of what that activity involved. There is an attribution to a particular type of manufacturer material or specific manufacturer. There will be information entered, if it is known, about the composition of the material in terms of the fiber type. The general categories are amosite, crocidolite and chrysotile, as the previous — several speakers discussed the potency differences between these fiber types.

There is also information entered about the proximity, whether the person performed the work, whether they were near the work, or whether they were around the work as the concentrations will vary depending upon the proximity.

And then we begin the process of estimating the amount of time during the day. The individual might say well, you know, it was somewhere between 5 and 15 percent of the day, or there might be some other type of information that we will utilize to come up with a time estimate, realizing the exposure event was an annual experience. Looking

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at the activities, it is a daily experience. So during the day there is some portion of the day that is directed toward this activity that was described as cutting the hole through the floor. It is clearly not an all-day activity, some portion of the day. So that information would be entered here.

The frequency is going to be the number of hours per day, not in terms of the percent of the day, but whether it was an eight-hour workday, a welve-hour workday, a ten-hour workday, we need to djust the equivalent number of years that that would epresent, and thus adjust accordingly the number of iber years calculations.

There might be information about the requency per week, it might be five days a week, it ight be only one day a week. It might be once every wo weeks, in which case the time that would be ntered would be .5.

Then we are going to estimate the ight-hour time-weighted average if the person were have performed the job all day long, as if it were eight-hour time-weighted average. That will then adjusted based on the percent of the day that the rson actually performed the work.

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If there is information on the attribution a specific material, realizing there are a number manufacturers of the same type of product, if ere was a specific interest in looking at a nufacturer's material, we can enter the percent of that that particular manufacturer represented.

We do this for each activity. Each ivity for each event. So, this process is a mulative one.

We have links to a library of data sources t allow as a basis for either the estimates of e, the estimates of concentration, the duration of activity, the content of the material. So at h step in the process, if there is a linkable rence, we can link to it.

By then clicking on that particular rence, we can call it up out of the database. We e approximately 1200 specific references in our base.

When we then go back to looking at the t summary, we have the individual activities with event, and we can take a look at the effective n dose associated with this specific event. Along way it is calculating and recalculating the dose e information is updated.

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This total dose is then reflected on the first sheet that I had shown you, which are the individual line items, and there are many of them, which are — each are called an exposure event, which when added together form a cumulative dose that we call an effective median dose, in this case, it is about 24 fiber years for this individual's total dose.

We also can perform a Monte Carlo analysis on this accumulation of information. It is analyzing the variability associated with time, variability associated with concentration, variability associated with the estimates that are being used in this reconciled reconstruction of a person's work history.

The output of the Monte Carlo analysis, as Dr. Rasmuson spoke, is a probability distribution with a mean in this particular case of about 27 fiber years. So 95 percent confidence — 90 percent confidence, the range for this individual was between 24 and 29, almost 30 fiber years for a cumulative lifetime dose. And this is built on the systematic slicing up of the information into component parts where we can provide estimates of time and exposure through concentration.

There is also an output from the analysis

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to look at the statistics of the inputs and outputs as well as a sensitivity analysis on which of the particular inputs had the greatest variability associated with them and thus would influence the results most significantly.

So not only do we get an output in terms of a range, we also get an analysis on which particular input variables effect the output the most significantly. And this is that sensitivity analysis, and it says in this particular case, it says that this particular activity, which you can go back to the chart, was the highest ranked as having the greatest influence on the results.

As a result of having this, you can go back to see whether you can refine the results or refine the input more carefully, or whether it just happens to be the activity for which we have the least amount of information.

There are various outputs then that would be produced in terms of a report. This is a summary of the references that were used in compiling the basis for the ultimate dose calculation.

A dose analysis summary, which looks at the individual's work history in terms of chronological time, this being the oldest exposure,